LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published by

The Texas Company, 135 East 42nd Street, New York City

Vol. XXIV | July, 1938 | No. 7

Change of Address: In reporting change of address kindly give both old and new addresses.

Selecting the Lubricants for Air Conditioning and Electric Refrigeration Machinery

A VARIETY of chemicals adapted to refrigeration purposes have been popularized by the development of the air conditioning or comfort cooling industry and its counterpart—electric refrigeration. Some are practically inert; others in turn are miscible with petroleum lubricating oils; while still others seem to have little or no tendency towards reaction or solution with the latter. We were dealing with this third classification when ammonia and carbon dioxide were the predominating refrigerants. Later as sulfur dioxide was applied to lower pressure units, the possibility of chemical reaction had to be anticipated, especially in the presence of moisture; this imposed the requirement of high dielectric strength in the lubricating oil, a feature which has come to be regarded as one of the most important characteristics today. Most recently has the industry had to consider the viscosity-reducing effects of the chlorinated and fluorinated refrigerants, such as Carrene, methyl chloride and the "Freon" group.

All this has imposed a most exacting obligation upon the petroleum industry, to develop a type of lubricating oil which will resist these changes as much as possible. It has required intensive research, and most precise methods of refinement.

REFINERY PROCEDURE

When it first became incumbent upon the oil industry to investigate the manufacture of lubricating oils for this type of refrigeration, the pour test was regarded as the salient characteristic, and refinery procedure was patterned accordingly. Later, it was developed that chemical stability, as measured by resistance to oxidation required even more careful consideration. So this became the primary objective in the manufacture of such oils; the several physical characteristics such as viscosity range, moisture content, pour and flash points are regarded chiefly as control factors to be developed in the course of refinement according to specific requirements of the machinery builders. All this has required that most careful consideration be given to refinery methods which would assure of maximum removal of unsaturated hydrocarbons, which latter have been proved to be most susceptible to chemical breakdown.

The Detriments of Water

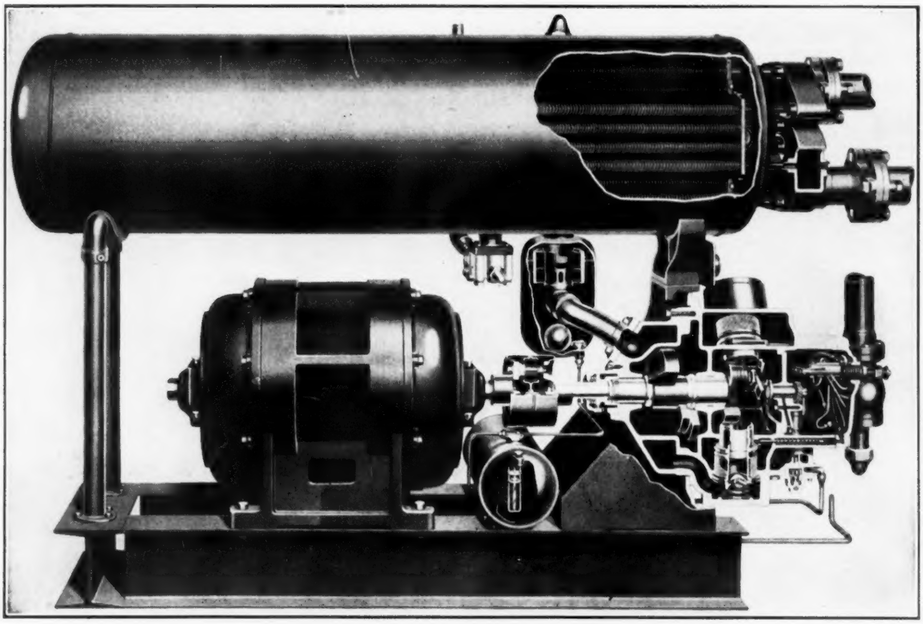
At the same time it has been found necessary to take the utmost precautions to keep such oils free from moisture, as this latter, when the oil comes in contact with certain types of refrigerants, accelerates corrosion, to

promote the formation of detrimental deposits or, even to enter directly into chemical reaction under certain conditions of pressure and temperature. Hence the adoption of a drastic dielectric strength requirement as part of the usual purchasing specification for refrigeration oils. An appreciable amount of water in any such system might also cause stoppage of the expansion valve due to freezing; ice formations in the cooling coils would also be a possibility, an occurrence which would reduce evaporative efficiency.

To offset the above where water cannot be entirely removed, some builders have added a small amount of alcohol as an anti-freeze, using the anhydrous methyl variety. Alcohol, however, can best be regarded as a remedy, not a cure. Furthermore, most alcohols are not anhydrous, so careless action on the part of a service man may lead to introduction of sufficient water with the alcohol to subsequently cause serious deposits to develop. The presence of alcohol, even in its purest form, is also claimed to be objectionable, as it adds another chemical to the already complex assortment which is presented by the refrigerant, the lubricating oil and the usual metals employed in the system.

Moisture in refrigerating compressor service will be most likely to cause corrosion when sulfur dioxide is being used. Sludge or objectionable deposits will in turn be experienced with methyl chloride, Carrene and the "Freon" group.

The initial charges of refrigerant and oil therefore, must be virtually water-free, and care must be taken to prevent the occurrence of leaks which might lead to entry of moisture-laden air and subsequent condensation of moisture. All this, of course, becomes a function of the manufacturer in the original design and construction of the unit, and the service man in its maintenance. In turn, it becomes the function of the manufacturers of the refrigerant and lubricating oil to prepare their products so that these will also be quite dry.



Courtesy of Airtemp, Inc., Chrysler Subsidiary

Fig. 1—The Airtemp 7-cylinder Air Conditioning Unit. This design provides for a dry crankcase using two oil pumps; one for delivery of oil under pressure, the other for scavenging the crankcase. Airtemp also provides an effective oil separator, and an auxiliary oil storage tank adjacent to the crankcase to which all return oil is drained.

Dielectric Strength

Moisture content in petroleum lubricating fractions became of consequence with the development of the electric transformer, and the use of light viscosity lubricating oils for insulating and cooling purposes. Obviously, such oils had to show maximum insulating qualities; water would reduce these materially.

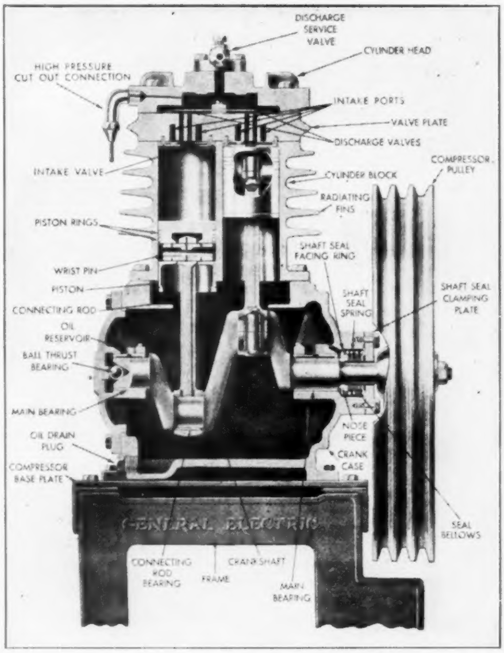
The test developed was of an electrical nature. It determined the absence of water by the resistance offered to passage of electric current. Petroleum oils are excellent non-conductors of electricity when virtually free from entrained moisture; under such conditions but a negligible amount of current can

pass. So the test procedure involves subjecting the oil under consideration to high voltage in a standardized test cup fitted with fixed gap electrodes of copper or brass. Resistance of oils to a stress of at least 21,000 volts per millimeter was found to be an indication that they were sufficiently dry for transformer purposes.

With the advent of methods of refrigeration requiring oils of like dryness, obviously this test for dielectric strength became of equal value to the petroleum chemist in refining and treating his lubricants for compressor service. Minute traces of moisture or solid materials have a very definite effect on reducing the dielectric value of an oil. In refinery procedure, concluded by filtration, the presence of any of these materials is completely eliminated. A variety of materials can be used for filtration. Filter press methods have proved to be most dependable, using a special grade of filterpaper for moisture absorption.

Care in Handling Lubricating Oils

Petroleum oils which have been actively dehydrated will tend to re-absorb a certain amount of moisture when exposed to the air for any length of time. This will result in reduction of their dielectric strength, dependent upon the relative humidity of the air, the temperature range and the length of time they have been so exposed. They should therefore be carefully stored and the containers opened only when it is necessary to use the oil; subsequently, if any oil remains unused the containers should be sealed as tightly as possible using special air-tight replaceable tops when cans are involved, or sealing gaskets on metal drums. Before usage it is always advisable to keep containers of oil at room temperature, or the temperature of handling, for at least twenty-four hours. This will assure of an equalized temperature, and will reduce the possibility of moisture condensation in the oil and impairment of its dielectric strength.



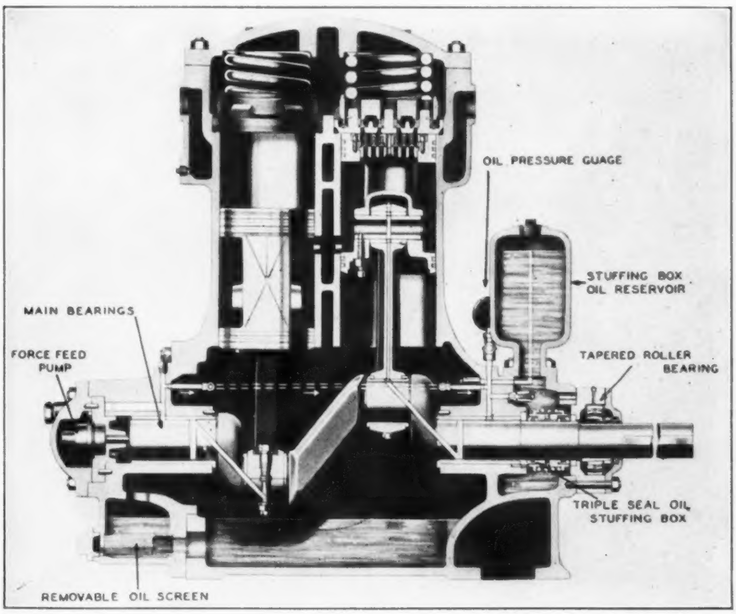
Courtesy of General Electric Company

Fig. 2—Sectional view of the General Electric CM Compressor showing details of construction. Note in particular the bearing design and relative location of the lubricated parts.

It is always perfectly feasible to bring back the dielectric strength by refiltration through specially dried blotting paper, but this is a costly procedure which careful handling of the oils should render unnecessary.

Pour Test Control

The pour point of a petroleum oil is the lowest temperature at which it will pour or flow when chilled without disturbance under definite prescribed

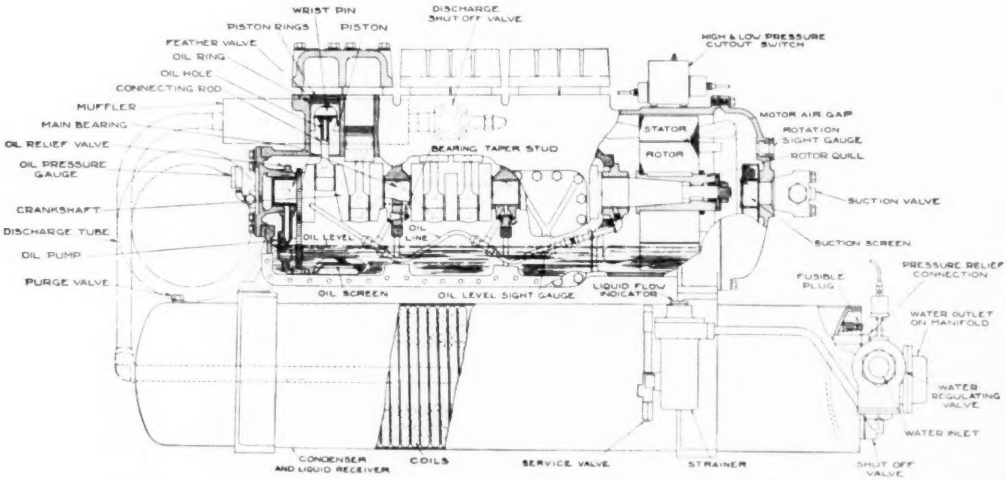


Courtesy of The Vilter Manufacturing Co.

Fig. 3—Cross section of a Vilter "Freon" compressor showing the force-feed oiling system and triple-seal. Vilter uses an automatic reversible gear type oil pump, as indicated, and a specially designed method of sealing the stuffing box by oil flooding. This provides the necessary seal, protects the metallic surfaces and prevents gas leakage.

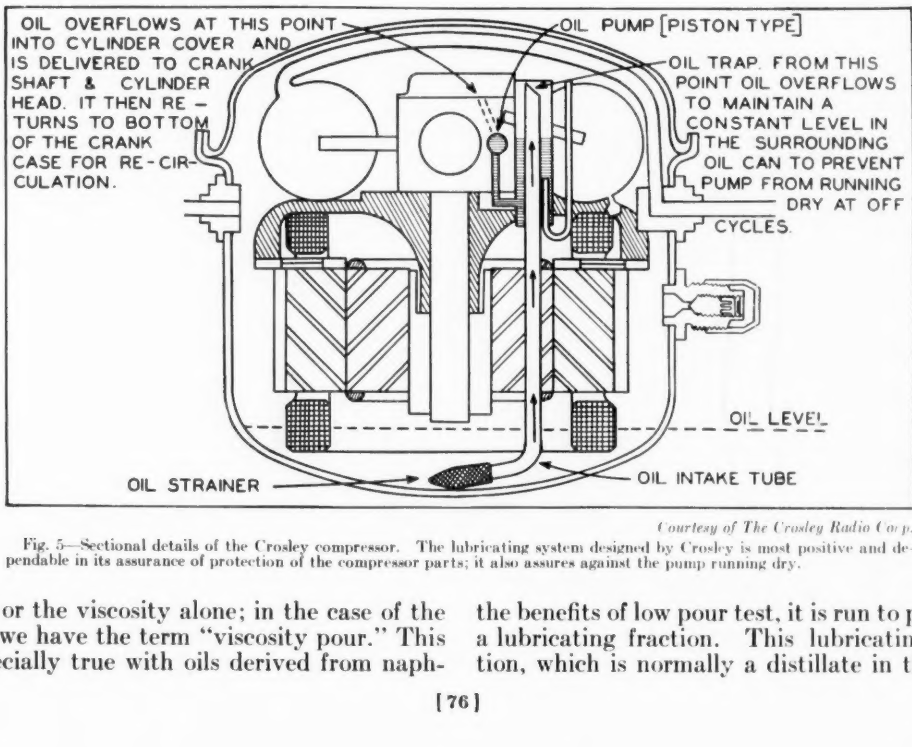
conditions. This test is, therefore, of prime importance in the consideration of a refrigerator oil. It is usually associated with the wax content and viscosity of the oil. In other words, as these increase they will materially affect the pour test. Some heavy lubricants for example may have a pour test as high as normal room temperature. Here the recorded pour test may be due to both the wax content and the viscosity or the viscosity alone; in the case of the latter we have the term "viscosity pour." This is especially true with oils derived from naphthenic base crudes, which naturally contain a minimum amount of wax. With modern methods of refining it is possible to overcome this obstacle, to a great extent, by employing some one of the modern solvent refining processes.

The sequence of manufacture is of distinct interest and exceedingly important. After careful segregation of the crude to balance the relative value of its other characteristics against the benefits of low pour test, it is run to produce a lubricating fraction. This lubricating fraction, which is normally a distillate in the case



Courtesy of Westinghouse Elec. & Mfg. Co.

Fig. 4—Internal construction of the Westinghouse type CLS-850 condensing unit. In this device the motor is totally enclosed and cooled by the refrigerant gas returning from the evaporator. The oil pump is mounted on the end bearing opposite the motor end of the compressor. Via drilled crankshaft and connecting rods, full pressure lubrication is developed throughout the machine.



Courtesy of The Crosley Radio Corp.

Fig. 5—Sectional details of the Crosley compressor. The lubricating system designed by Crosley is most positive and dependable in its assurance of protection of the compressor parts; it also assures against the pump running dry.

of refrigerator oils, is then subjected to intensive chemical treatment and filtration. The cost factor has dictated that refrigerating oils are refined most economically from naphthene base crudes, although recent developments in solvent dewaxing refining have indicated the practicability of starting with a paraffin base crude and arriving at similar objectives by using various combinations of refining and dewaxing; manufacturing costs, however, may be increased.

Flash Point

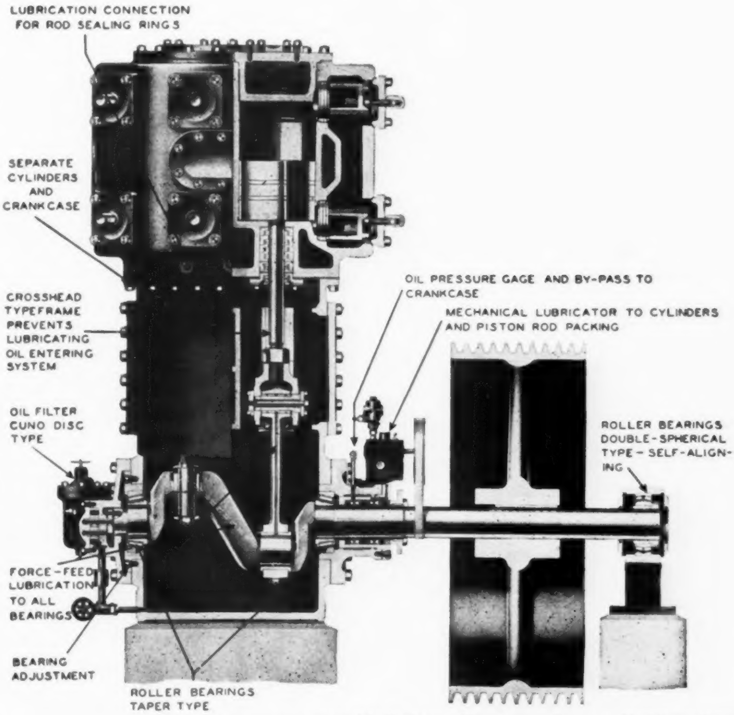
While the average air-conditioning or refrigeration compressor will function at maximum temperatures considerably below 200 degrees Fahr., there will be times when an installation of the booster type may approach 300 degrees Fahr., on the discharge side. For this reason the flash point as an indication of the relative vaporizing tendency of petroleum lubricating oil, must be given consideration. Fortunately, the flash point of even the lower viscosity oils will be sufficiently above 350 degrees Fahr., to preclude any abnormal vaporization and thickening of the oil.

A further indication of the degree of refinement is the extremely low tendency to form carbon residue on heating which will be shown by such oils.

Viscosity—Reduction

The tendency which mineral oils will have to mix or go into solution with the chlorinated or fluorinated refrigerants has fostered a decided interest in the subsequent viscosity of the mixtures. In the beginning it led to consideration of oils of somewhat heavier original viscosity than subsequent experience proved were necessary. The fact that a 300 viscosity oil would be reduced to an operating viscosity range of, let us say, 90 seconds Saybolt Universal at 100 degrees Fahr., by admixture with ten per cent of "Freon" or methyl chloride, caused the skeptics to wonder as to the lubricating value of the mixture. Still doubting, they raised the original viscosity of their oil to be on the safe side, in an effort to keep their operating viscosity at least 100 seconds at 100 degrees Fahr.

Others, more willing to investigate the lubricating value of lower viscosity oil-refrigerant mixtures, carried out exhaustive laboratory and service tests. The resultant performance of the lighter viscosity refrigerating oils within say a range of 150 to 300 seconds Saybolt Universal at 100 degrees Fahr., has been convincing. It was definitely indicated that they were capable of affording entirely dependable lubrication even though the viscosity of the lubricating film was materially reduced by the refrigerant. This has justified the use of such oils by a number of builders who even go so far as to apply the same oil to both "Freon" and sulfur dioxide units.



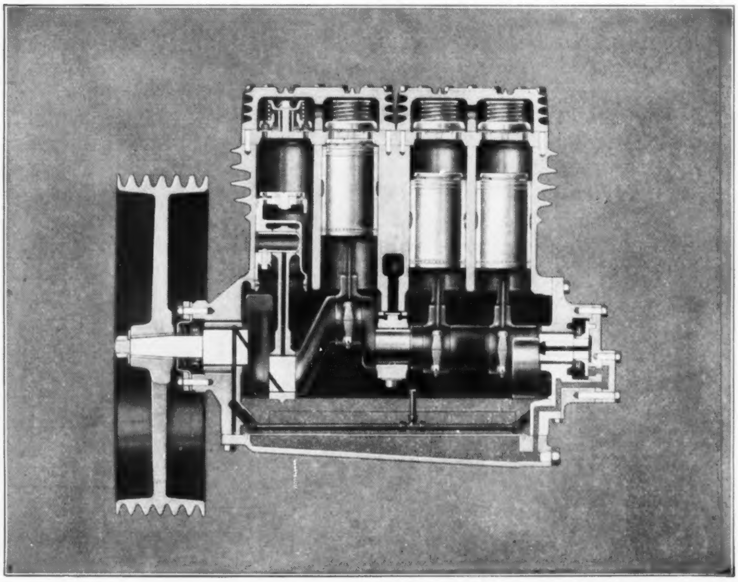
Courtesy of Carbondale Division—Worthington Pump & Machinery Corp.

Fig. 6—Lubrication details of the Worthington-Carbondale vertical, duplex, double-acting enclosed crankcase refrigeration compressor. By pressure lubricating the bearings and cylinders independently, control of oil flow to the latter can be positively maintained. With the added precaution of filtering the crankcase oil, protection against contamination is attained.

How Miscibility is Affected

In studying this matter of mutual solubility of mineral lubricating oils with "Freon" refrigerants, methyl chloride or Carrene, it is essential to understand that the physical nature of the refrigerant is all-important. In other words, in the liquid phase, the above refrigerants are all entirely miscible with petroleum oils. When these refrigerants are in

the gaseous phase, however, the oil is almost entirely liquid; as such it absorbs only a small portion of the gas. In other words, the respective refrigerant vapors will go into solution less readily, all dependent upon the prevailing pressures and temperatures. So in studying this phenomenon, in the interest of improving lubrication, or protecting the lubricating ability of the oil, effort should be made to duplicate the operating conditions as far as possible.



Courtesy of Frigidaire Division—General Motors Corporation

Fig. 7—Cut-away view of the Frigidaire four-cylinder air conditioning compressor. Lubrication of this machine is entirely automatic and planned to conform with the precision to which the respective moving parts are built.

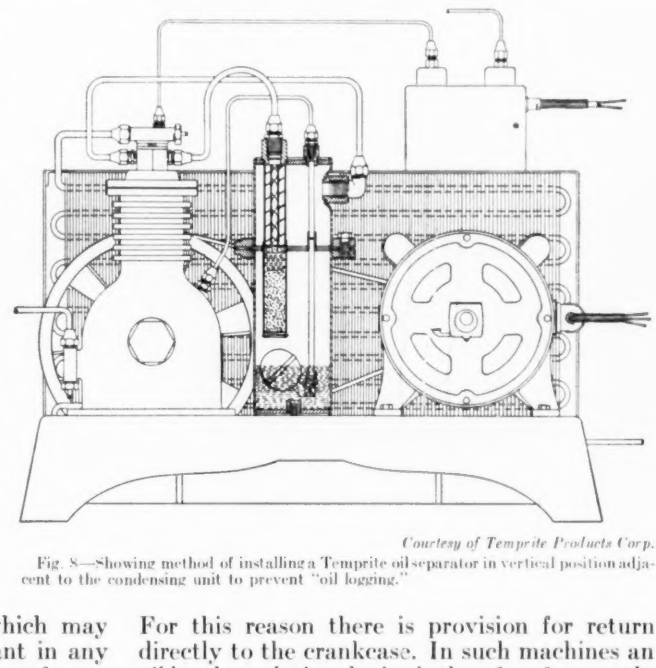
The amount of any such refrigerant which may be absorbed by a mineral oil will be dependent also upon the viscosity of the oil at the temperature of contact and the pour test of this oil.

The viscosity bears a relation in that as it is increased the amount of refrigerant absorbed will decrease. In turn, larger amounts of "Freon," Methyl chloride and Carrene are absorbed by mineral oils at higher pressures and lower temperatures, just as smaller amounts will be absorbed at lower pressures and higher temperatures.

TYPE OF COMPRESSOR A FACTOR

The amount of compressor oil which may come into contact with the refrigerant in any such system will depend upon the type of compressor, and the method of sealing. The centrifugal machine presents a comparatively simple problem involving the lubrication of ring-oiled bearings and the maintenance of a seal against loss of vacuum. Normally, a certain amount of leakage of the refrigerant, which may be any one of the chlorinated or fluorinated materials, will occur; it will not be sufficiently extensive, however, to give any concern as to the resultant lubricating ability of an oil which has been specifically refined for this class of service, as the refrigerant content will usually be below ten per cent.

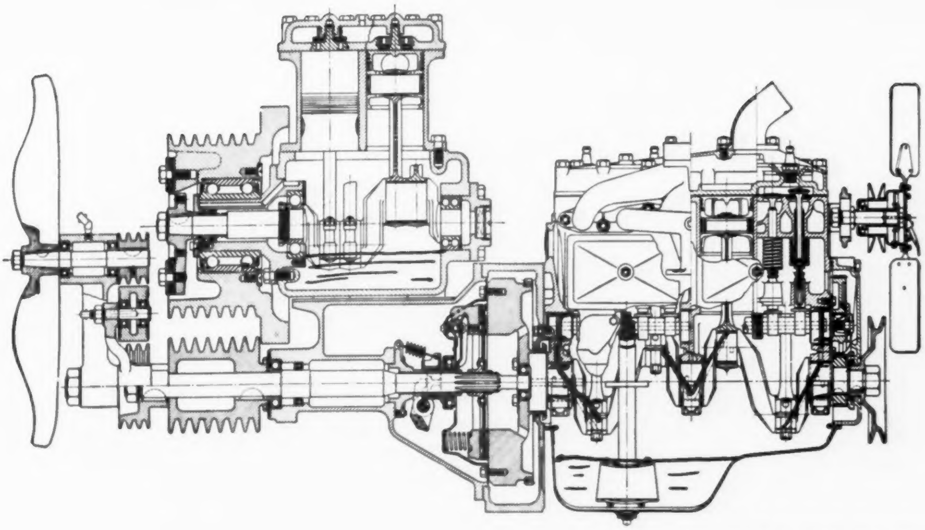
Reciprocating compressors, however, require consideration of the method of lubrication. Small tonnage units designed for splash lubrication, as are so many of the vertical unit type railway or household machines, depend upon oil throw from the crank to splash the necessary amount of oil to the cylinders. Some of this oil is bound to pass over to the high pressure side and become mixed with the refrigerant.



Courtesy of Temprite Products Corp.

Fig. 8—Showing method of installing a Temprite oil separator in vertical position adjacent to the condensing unit to prevent "oil logging."

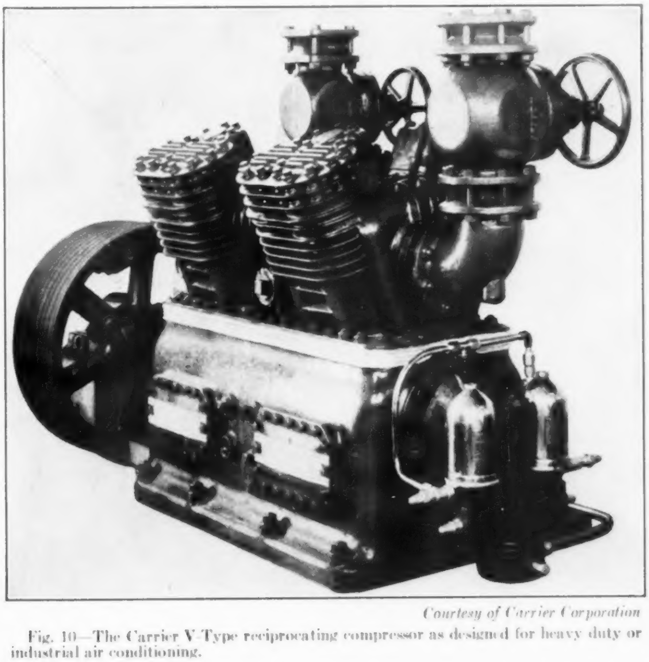
For this reason there is provision for return directly to the crankcase. In such machines an oil level regulating device is therefore frequently



Courtesy of Waukesha Motor Company

Fig. 9—Showing a Waukesha ice engine installation in detail with oil level indicated in the crankcases of both the engine and compressor. Lubrication of this latter is maintained entirely by splash.

installed, although if care is observed not to charge the compressor with too much oil to begin with, oil level regulation may not be necessary; it is, therefore, not always used on the small unit type of machine. In turn, the trend on many larger units is toward the use of pressure lubrication, and the installation of suitable pumping mechanisms.



Courtesy of Carrier Corporation

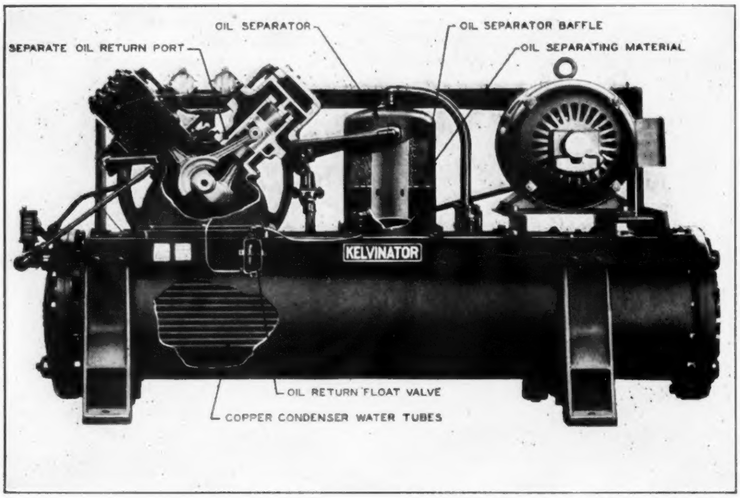
Fig. 10—The Carrier V-Type reciprocating compressor as designed for heavy duty or industrial air conditioning.

Control of Refrigerant Vapors

Compressors of the reciprocating type can also be built so that the refrigerant vapors are kept entirely apart from the crankcase. Construction of this nature largely eliminates the possibility of the oil becoming mixed with an excess of refrigerant. This enables the oil to maintain its original viscosity, or merely to follow the normal reduction in viscosity which would take place as the crankcase comes up to average operating temperature. This condition will prevail in the enclosed crankcase machine equipped with trunk-type pistons and designed for pressure lubrication. The oil pump maintains a positive circulation of oil without excessive splash effect, therefore, foaming is markedly decreased. Reduction of oil splash in turn reduces the tendency of any refrigerant present to mix with the oil supply, especially as there is no circulation of refrigerant vapors within the crankcase.

Location of the oil pump in such a machine must of course be carefully studied; some authorities recommend that it be at the lowest point in the case to insure against loss of suction and the resultant reduction in volume of oil circulated which might readily lead to impaired lubrication. Others have studied and applied the principles of dry sump lubrication to good advantage, using a

pressure pump for oil circulation and a scavenging pump for the return.



Courtesy of Kelvinator Corporation

Fig. 11—The Kelvinator V-Type condensing unit assembly showing certain of the parts pertinent to lubrication. Note location and construction of the oil separator.

Central Station Service

In service where considerable tonnage is involved, the possibility of reduction of the oil viscosity by mixture with the refrigerant is further reduced by using the cross head type of vertical compressor as well as the horizontal double-seal stuffing box machine. In these units the refrigerant vapors are kept entirely clear of the base or crankcase of the machine; being returned directly to the cylinder block. As a result there is but little chance of the oil in the case becoming mixed with refrigerant, so here again foaming is eliminated along with reduction in viscosity.

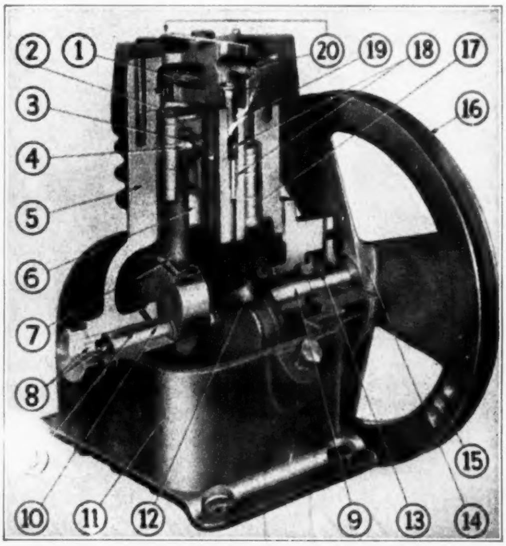
Since lubrication of the crankcase elements or external parts is maintained entirely independent from the cylinders, it is customary to provide for injection of a certain amount of oil into the refrigerant return line or directly to the cylinder and stuffing boxes to take care of piston and valve lubrication and protection of the cylinder walls against scoring. This oil can be subsequently separated from the refrigerant by judicious installation of the oil separator.

FUNCTION OF THE OIL SEPARATOR

This element as its name implies serves to remove entrained oil from the refrigerant. It proved its value very early in the development of the refrigerating industry as a means of improving the efficiency of ammonia and carbon dioxide in ice making and cold storage machines. Later, with the acceptance of the chlorinated or fluorinated refrigerants and their susceptibility to direct mixture with petroleum lubricating oils, the oil separator again came to be depended upon, especially in larger installations; here it served an added purpose, as an assistant to maintenance of the oil viscosity.

The separator, therefore, is of value wherever an excess of oil might otherwise find its way to the evaporating or cooling side of a refrigerating system. Such a device is most effective where it is capable of removing particles of oil from the refrigerant while the latter is in gaseous form, after it has left the compressor. The larger the oil particles, of course, the more effective will be the separator. It should, therefore, be located at a sufficient distance away from the compressor to permit of adequate precipitation of the oil from within the refrigerant.

The capacity of any separator should be ample so that the velocity of the gas passing through will not be too high. But we must realize that should an excessive amount of oil



Courtesy of Copeland Refrigeration Corp.

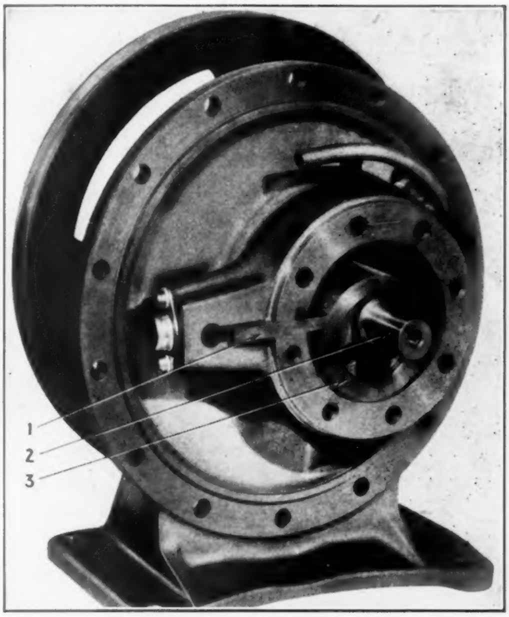
Fig. 12—The Copeland compressor, showing at (1)—Multireed discharge valve. (2)—Spring-disc intake valve. (3)—Lubricated wrist pin. (4)—Spring thrust washer. (5)—One-piece body. (6)—Diamond-bored, micro-honed, hand-lapped cylinder walls. (7)—Diamond-thrust ball with hardened insert and bored connecting rod. (8)—Shaft plug. (9)—Oversize bearing. (10)—Eccentric shaft. (11)—Crankcase. (12)—Directional oil distributor. (13)—Balanced seal. (14)—Fan-blade type spokes. (15)—Balanced flywheel. (16)—V-belt drive. (17)—Pistons. (18)—Cylinder and piston oiling system. (19)—Suction line screen. (20)—Service valves in head cap.

be fed to the compressor, a heavy load will be imposed upon the oil separator.

Location Affects Separation

The manner of location of such a device is very important. In general, it should be placed between the discharge of the compressor and the point of entry of the gas into the condenser, because the oil must be removed before the gas is liquefied. Where the oil fails to function properly, the reason is often because the separator is set too near the compressor, the rush of hot gas preventing proper condensation and collection of the oil.

Oil will be practically always atomized to a certain extent by virtue of the heat of compression which is prevalent. This oil mist will naturally tend to pass into the system with the refrigerant, to condense and remain in the colder parts, unless it is effectively removed before it enters the condenser. In consequence, the separator should be set as close to the condenser and as far away from the compressor as possible. It is always advisable that it should be of sufficient size to allow of ample reduction in the velocity of the gas in order to permit of effective separation. A smaller separator installed some distance from the compressor may often prove more effective than a large separator located nearby.

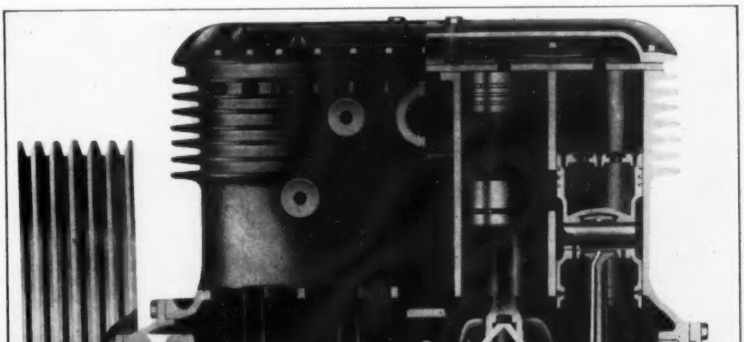


Courtesy of Norge Division—Borg-Warner Corporation

Fig. 13—The three moving parts of the Norge compressor as involved in the Rollator principle: 1, shows the blade; 2, the roller; and 3, the cylinder. All operate continually in a bath of oil.

Where it is impossible to locate the main oil separator elsewhere than adjacent to the compressor, it is well to use an oil of as low an atomizing tendency as possible. This property will usually accompany high viscosity. The choice of a heavier oil would, therefore, solve the problem to some extent. In general, an oil of a viscosity of about 300 seconds Saybolt at 100 degrees Fahr., will meet these conditions.

In compressors lubricated by controlled force feed the efficiency of an oil separator can often be checked by comparing the amount of oil removed from it with the amount fed to the compressor. Any extensive difference would indicate that the oil is not being entirely removed or trapped. Allowance, of course, should be made for oil leakage around the stuffing box, although to just what extent this may occur will depend upon the design of the individual installation, the care

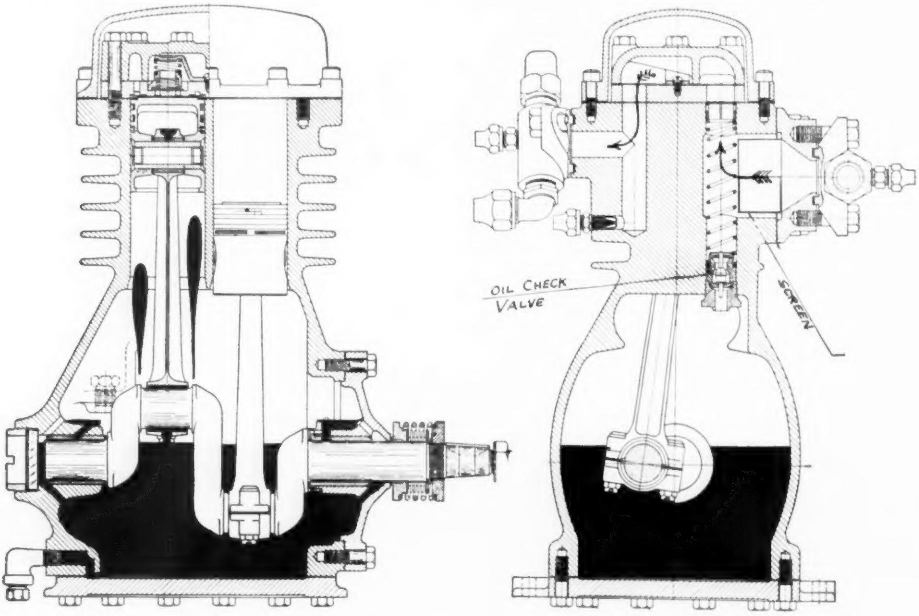


Courtesy of Baker Ice Machine Co., Inc.

Fig. 14—The Baker "Freon" compressor showing oil level in the crankcase, path of oil flow (by white lines) through crankshaft and connecting rods; and the application of roller bearings at the outboard ends.

given to lubrication, the original viscosity of the oil and the means by which this oil is circulated or applied.

"Freon" and Methyl chloride type provided a plunger-actuated belt-driven pump, on the outside of the machine. Through nozzles piped



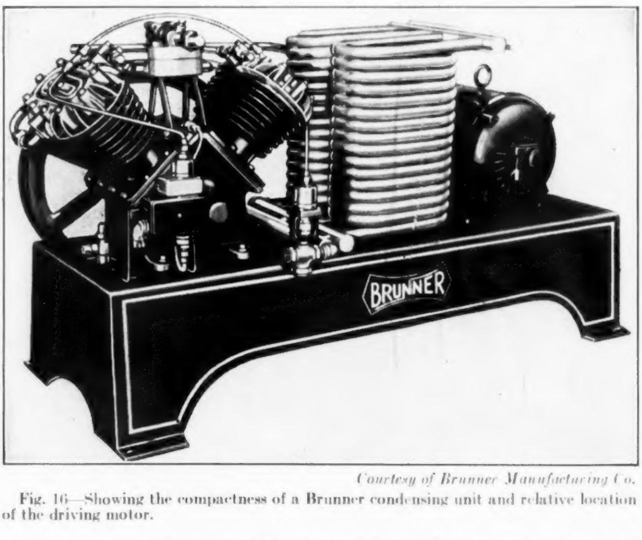
Courtesy of General Refrigeration Corp.

Fig. 15—Showing a medium speed, splash lubricated Lipman compressor. Large oil capacity and high oil level provide positive lubrication. The main bearings are gas vented, and fed by static oil pressure maintained in screened pockets. Connecting rods are lubricated by the velocity-pressure of the oil. Pistons and pins are lubricated by copious quantities of oil thrown on the walls and up the rods. Pistons are of the automotive type, and oil pumping is ring controlled to provide sufficient lubrication to valve parts. Because of the high level and large capacity, an oil check valve is provided to eliminate priming. This valve is a streamlined ball suspended in an inverted cone. Oil foam raises this ball, which throttles the opening, checks the flow of vapor responsible for priming, and thus breaks down the foam. When the valve drops, any oil returning with the suction vapor may return to the crankcase.

DESIGNING FOR LUBRICATION

Compressor lubrication is being studied more and more with regard to its relation to capacity or efficiency. This will hold true regardless of the type of lubricating system employed. There must be adequate lubrication, but not a continued excess, for immediately this latter occurs, the possibility of oil slugging will develop. Lindgren* has pointed this out most aptly in his discussion of figure 12. In his research pertaining to the smaller type of machines where an oil pump would be prohibitive due to cost and noise, he found that the capacity of the crankcase was especially important in the splash lubricated machine; the larger the crankcase the greater the possibility of reducing pressure variations and carrying a lower oil level.

The Baker System which was the first method of force-feed lubrication applied to compressors of the inside the frame, oil was injected and sprayed to all the working parts. Today, Baker uses a gear-driven pump, however, direct-connected



Courtesy of Brunner Manufacturing Co.

Fig. 16—Showing the compactness of a Brunner condensing unit and relative location of the driving motor.

to the crankshaft, taking oil from the base of the compressor through filters of heavy felt

* George Lindgren, in "Air Conditioning and Electric Refrigeration News," November 4, 1936, concerning the Copeland design.

and steel gauze. Thence it is pumped through the hollow crank-shaft and connecting rods to all main bearings within the compressor.

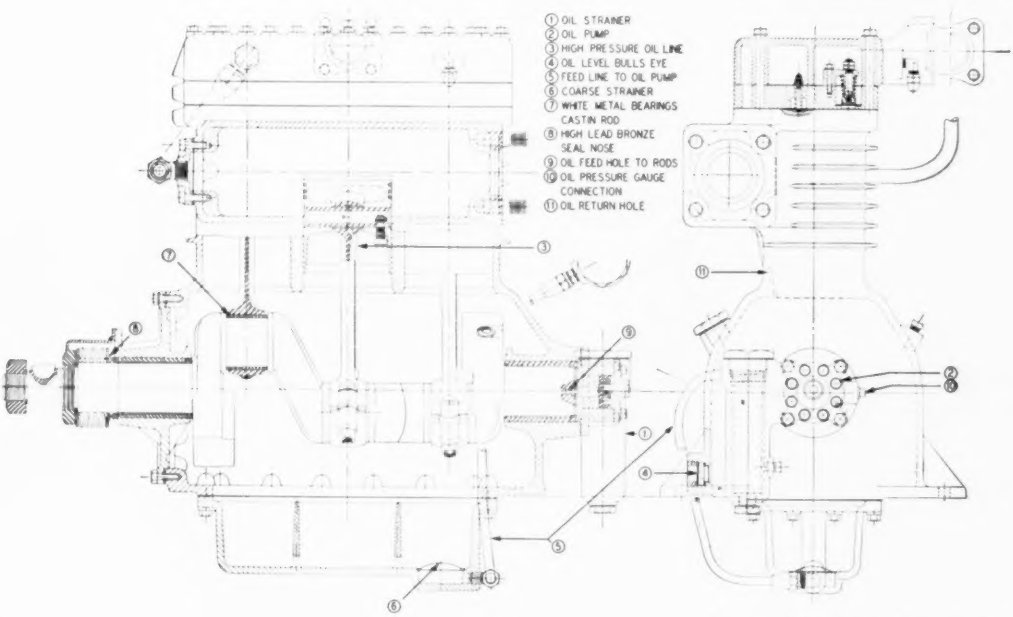
Other research authorities—notably C. R. Neeson of Airtemp have gone one step further in their application of force-feed lubrication by providing for a dry crankcase, using two oil pumps, one for pressure delivery, the other for scavenging the crankcase.

Universal Cooler Corporation, in turn, equip their larger compressors with an exterior tube connection from the oil sump to their force-feed rotary pump. Oil is delivered through the crankshaft to the crankpins and main bearings, and via a separate copper tube connection from the crankpins to the piston pins. This type of controlled lubrication facilitates control of the crankcase oil level and likewise reduces pressure variations and the tendency towards foaming.

Worthington-Carbondale has also perfected a full pressure lubricated vertical reciprocating compressor which is unique for its utilization of two separate lubricating systems: (1) a gear type oil pump with filter attachment for delivery of oil under uniform pressure to all the bearings; and (2) a mechanical lubricator for measured delivery of oil to the cylinders and piston rod packing. Flood lubrication of the cylinder walls is prevented by the use of piston rod packing where the rods pass from the cylinders into the crankcase. The latter, in turn, being entirely enclosed and pressure tight, precludes any possibility of dilution of the crankcase oil by the refrigerant or loss of oil by entrainment with the latter.

Methods of Lubrication

The intricacy of the lubricating system will depend upon the type and capacity of the compressor. The centrifugal machine requires the least complex system since there are only the bearings of the rotor to be lubricated. These are taken care of by ring oilers. Simultaneously, however, the oil performs an additional function in maintaining an automatic oil seal against loss of vacuum.



Courtesy of Universal Cooler Corporation

Fig. 17—The Universal compressor in sectional detail showing certain of the parts pertinent to lubrication. A noteworthy feature is the force-feed rotary oil pump connected by exterior tubing to a sump of ample capacity to permit the oil to rest.

Reciprocating compressors on the other hand, present more parts to be lubricated and require circulation of the oil. This is accomplished by splash or force feed. The former is particularly applicable to the fractional tonnage units so widely used for household refrigeration. While the idea has been taken from automotive practice, some very unique means have been provided by certain manufacturers to assure of positive circulation especially to the cylinder walls. Stewart Warner for example, have cut grooves in the sides of the pistons to develop a positive oil supply, using special oil slinger paddles attached to the eccentric to splash oil onto the cylinder walls and into the reservoirs, which lead to the bearings. Servel in turn build a special oil feed into the

piston itself to assure that this latter will be self-lubricating.

The Use of Splashers

Splash lubrication is devoid of the possibility of starved lubrication provided the compressor parts are designed for thorough circulation of the oil after this is begun by the crank splash elements. All that is necessary usually is to maintain a suitable oil level to enable the splashers to dip to a sufficient extent at each throw of the crank-shaft. Copeland assures this by employing splashers so placed that they will pick up oil even though the level may be below the point at which a conventional crank would be "out of oil" so to speak.

Pressure Systems

With the advancements in heavier tonnage design to meet the requirements of commercial refrigeration and air conditioning, the adaptability of pressure became the subject of considerable research, designed to function either alone or together with splash. Here the objective was to obtain positive circulation of oil throughout the compressor and to eliminate foaming as far as possible. Obviously in a splash lubricated reciprocating compressor, foaming will always be present. The extent to which it may be objectionable will depend upon the oil level, and the location of the suction valves. Inasmuch as the unit type of compressor usually takes its suction through the crankcase, if the foam level rises to a sufficient degree, foam may be carried over to the high side with the refrigerant to cause serious retardation of heat transfer. Ultimately, if allowed to continue, cleaning of the system may be necessary. The attendant expense is, of course, objectionable. To obviate this some builders have arranged their design so that all refrigerant gases and vapor are excluded from the crankcase.

An added advantage can be obtained by adequate sealing of the lubricating system. This is the practice at Vilter, where the force-feed lubricating system is of the hermetically sealed internal type. In this design an automatic reversible gear pump is used, the system being so arranged that the stuffing box is kept flooded with oil; this provides an oil seal at the contact faces of the metal seal, to assure proper lubrication, prevent gas leakage and eliminate overheating of the seal rings.

Pump Design

It is extremely interesting to note the advancements which have been made by the industry in perfecting pumping devices for positive handling of lubricating oil throughout the compressor mechanism. Today there is a definite trend towards controlled lubrication, especially where dealing with refrigerants which are miscible with mineral lubricating oils. This has required consideration of strainers and oil separators along with pump design. All are more or less related to compressor efficiency and capacity, viz., a continued excess of oil will lead to slugging and reduction in efficiency, yet there must be a slight excess on starting to assure of positive lubrication of piston and cylinder walls, especially in the reciprocating machine. This can be assured by proper pump adjustment.

The Gear Pump

This element—an offshoot from automotive practice—has been proved to be as equally dependable in refrigerator compressor service. The gear pump as designed for positive delivery of oil, is a comparatively simple device, consisting of a pair of gears mounted in a suitable housing. The normal location of such a pump is in the base of the crankcase of the compressor, although some designers prefer to place this pump at the lowest part of the case. Others are of the opinion that the pump should be set just above a depression or catch basin in the case to provide means for trapping foreign matter and preventing it being circulated through the lubricating system. Usually, however, foreign matter in a well designed system using properly refined oil will be conspicuous by its absence.

Williams in their Ice-O-Matic Unit provide for "dry sump" lubrication, like Airtemp, employing a rotary gear pump and an auxiliary tank adjacent to the crankcase to which all return oil is drained.

Irrespective of the location of the pump, however, suction is automatically maintained by gravity, since the pump is below the normal oil level. In a typical system the discharged oil, under pressure according to the speed of rotation of the gears and their relative tooth dimensions, is led from the discharge side of the pump to the connecting rod bearings and other elements by drilled passages and suitable piping connections. As oil passes out from the bearing clearance spaces, or drips from the cylinder walls or other parts of the interior housing, it returns to the case or oil sump by gravity for recirculation.

Universal Cooler Corporation provide the added precaution of a strainer on the inlet side of the pump.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.
72 Washington St., N. Y. C.